Space Weather Technical Forecast

Issued on Wednesday, 14 June 2023 at 13:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of R1/R2 Radio Blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with peak flare C6.3 at 13/1738 UTC, likely from a new region just over the northeast limb. There are five numbered sunspot regions on the disc, with the four in the western hemisphere small and largely stable or declining. AR3333 in the southeast has rapidly shown growth in the last 24 hours, with ongoing flux emergence. This has a relatively simple E-W alignment but consists of a sequence of small spots with dark umbral cores with potential for further growth and complexification. Further spots are also rotating onto the eastern disc, including the likely source of the peak flare, however these are currently too close to the limb to ascertain a detailed analysis. No Earth-directed CMEs were observed.

Solar Wind / Geomagnetic Activity: The solar wind at L1 eased after recent fast wind enhancements. The solar wind speed, as observed by DSCOVR, declined from slightly elevated at around 450 km/s to around 350km/s, whilst the density decreased from around average to be below average. The total IMF, Bt was weak, remaining below 8nT, with the north-south component varying between +6 and -6nT. The phi angle was mostly positive (away from the Sun). Geomagnetic activity was mostly Quiet (Kp1-2), with an Unsettled interval observed at 14/0000-0300 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at background. High energy electron flux (greater than 2MeV), as observed by GOES16 was at background. The associated 24-hour fluence remained below the Active threshold (1e8 integrated pfu), with 1.97e6 integrated pfu observed at 14/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low activity is most likely to continue, however there is a chance of this increasing to Moderate with isolated M-flares (R1/R2 Radio Blackouts).These most likely from regions rotating onto the Earth-facing disc, or developing AR3333 in the southeast quadrant.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs. Solar winds are forecast to be at background to slightly elevated until the next fast wind enhancement, expected from CH12/- later on day 2 and into day 3 (15 and 16 Jun). Solar winds of around 500 km/s are forecast. Mostly Quiet geomagnetic activity at first, rising to Unsettled with Active spells with the fast wind enhancement. There is a slight chance of G1/Minor Storm intervals, mainly early on day 3 (16 Jun). Activity easing to Quiet with Unsettled intervals by day 4 (17 Jun).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at background. High energy electron flux (greater than 2MeV) is expected to continue at background, until after the fast wind enhancement, then likely becoming Moderate, perhaps briefly High later day 3 or day 4 (16 or 17 Jun). Electron fluence is expected to remain below the Active (1e8 integrated pfu) threshold.

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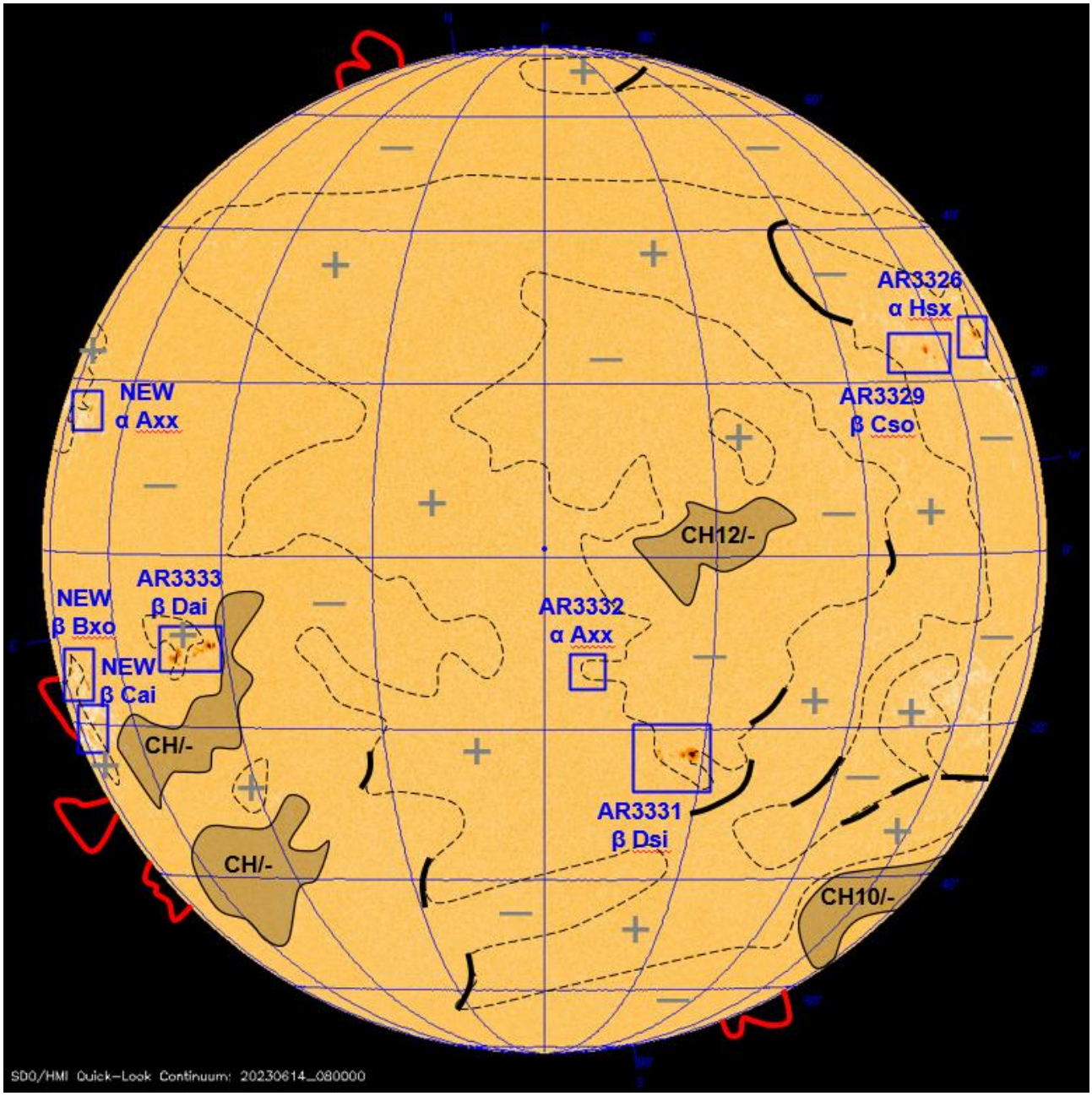
Figure 1. Solar Analysis Valid 14/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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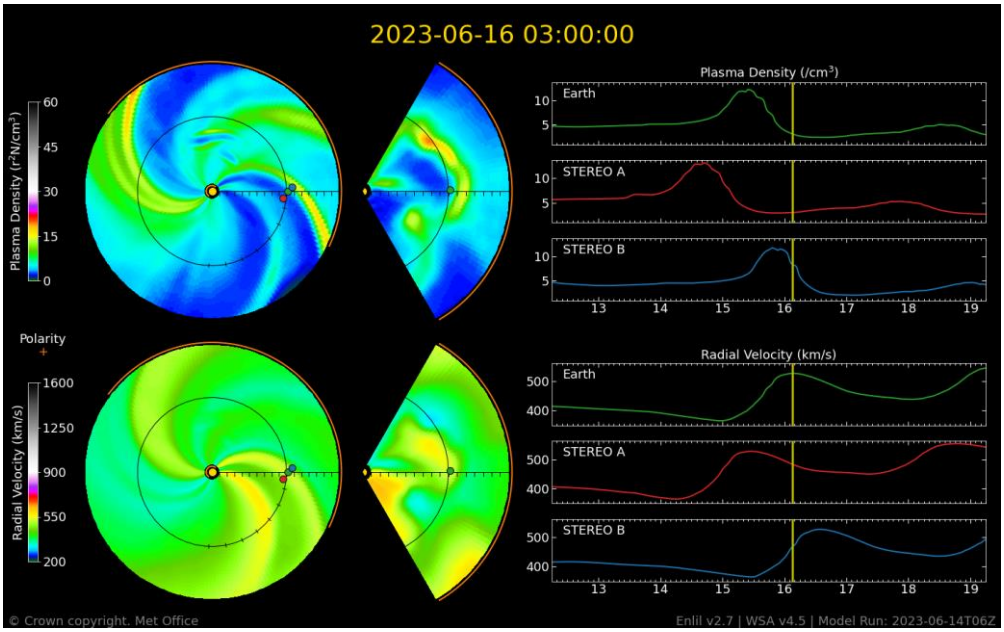
Geomagnetic Storms:
There are no Earth-directed CMEs.

Background to slightly elevated solar winds are expected until the arrival of any fast wind associated with the high speed stream (HSS) of CH12/- currently located just west of central disc. The CIR region ahead of this feature is forecast to arrive during the second half of day 2 (15 Jun), with peak solar winds likely early day 3 (16 Jun), before declining day 4 (17 Jun). 27-day persistence is currently a poor guidance due to a combination of altered CH structure, along with CME contamination on the last rotation, however Enlil is providing a good representation of expected winds, leading to moderate confidence that speeds of around 500 km/s can be anticipated.

Geomagnetic activity is forecast to be mostly Quiet, rising to Unsettled with Active spells with the fast wind enhancement. There is a chance of G1/Minor Storm intervals, mainly early on day 3 (16 Jun). Activity easing to Quiet with Unsettled intervals by day 4 (17 Jun).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	15	20	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Enlil shows the expected arrival of fast wind from CH12 late on day 2 (15 Jun) and into day 3 (16 Jun)



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Radio Blackouts - X-Ray Flares:
Activity across the Earth-facing solar disc has been Low, with four of the five numbered sunspots small and simple. The exception is AR3333 in the southeast. This region is rapidly growing, and while currently relatively small and simple, brings an increased risk of flaring.

Furthermore, significant magnetic looping is visible over the east limb on e.g. SDO aia-94, SDO aia-304 and STEREO A-euvi. These are beginning to rotate around the east limb, and are likely to increase the potential flare risk. However, how much remains very uncertain until these regions fully rotate around from the east limb into a more analysable location.

Overall, Low activity is most likely to continue, however there is a chance of this increasing to Moderate with isolated M-flares (R1/R2 Radio Blackouts).

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: GOES-16/18 X-ray flux

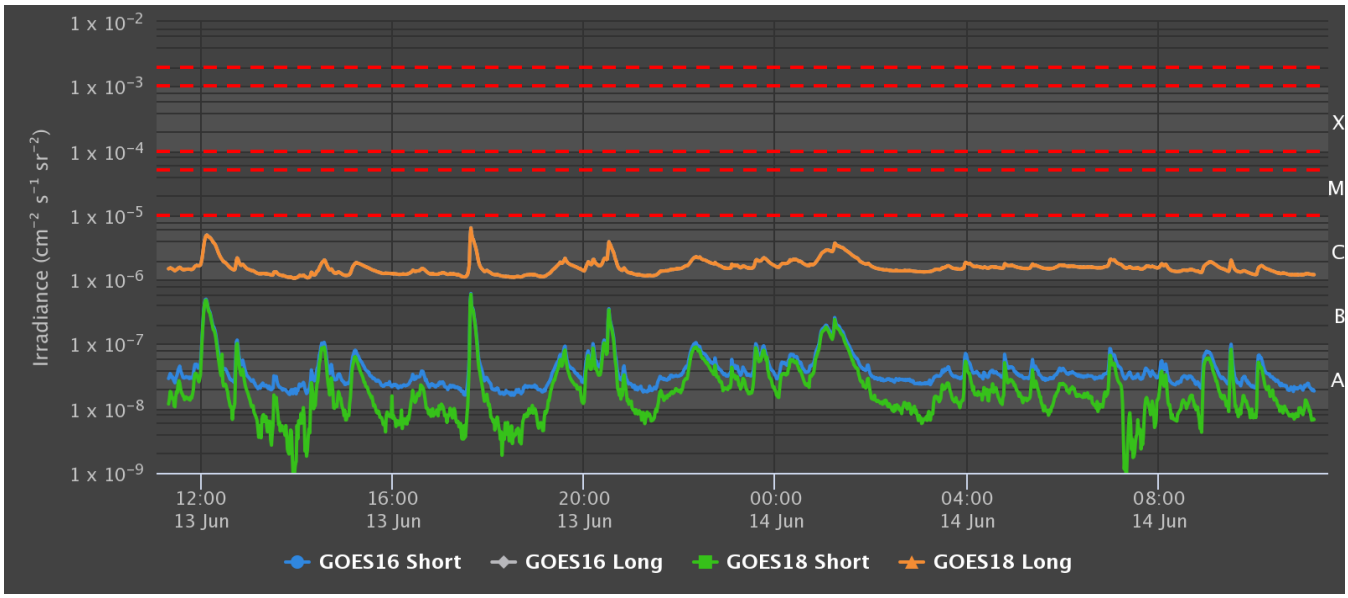

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Figure 4: AR3333 intensitygram (left) and magnetogram (right).

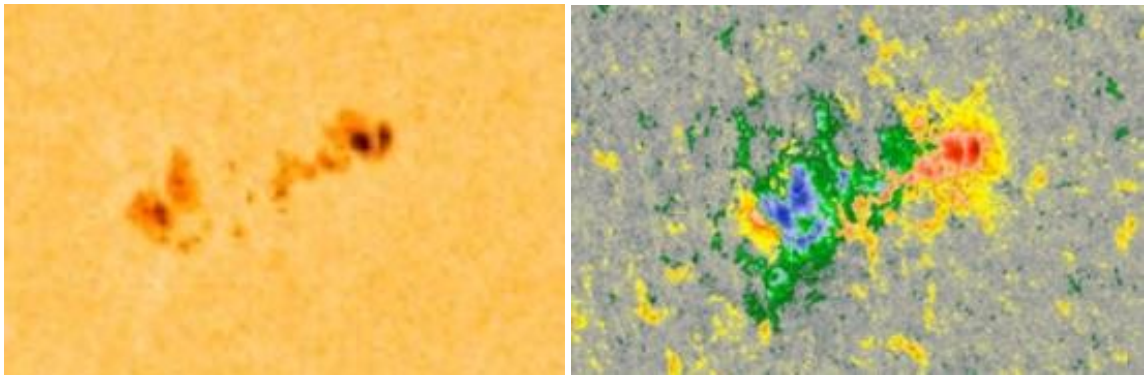
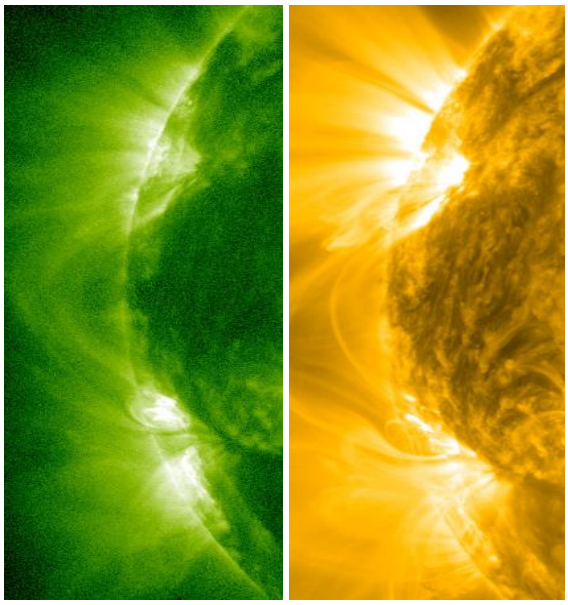


Figure 5: SDO aia-94 (left) and aia-171 (right) shows regions rotating onto disc.



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux is at Background levels and is expected to continue at this level, with only small, simple and declining sunspots currently in a geo-effective location on the Earth-facing disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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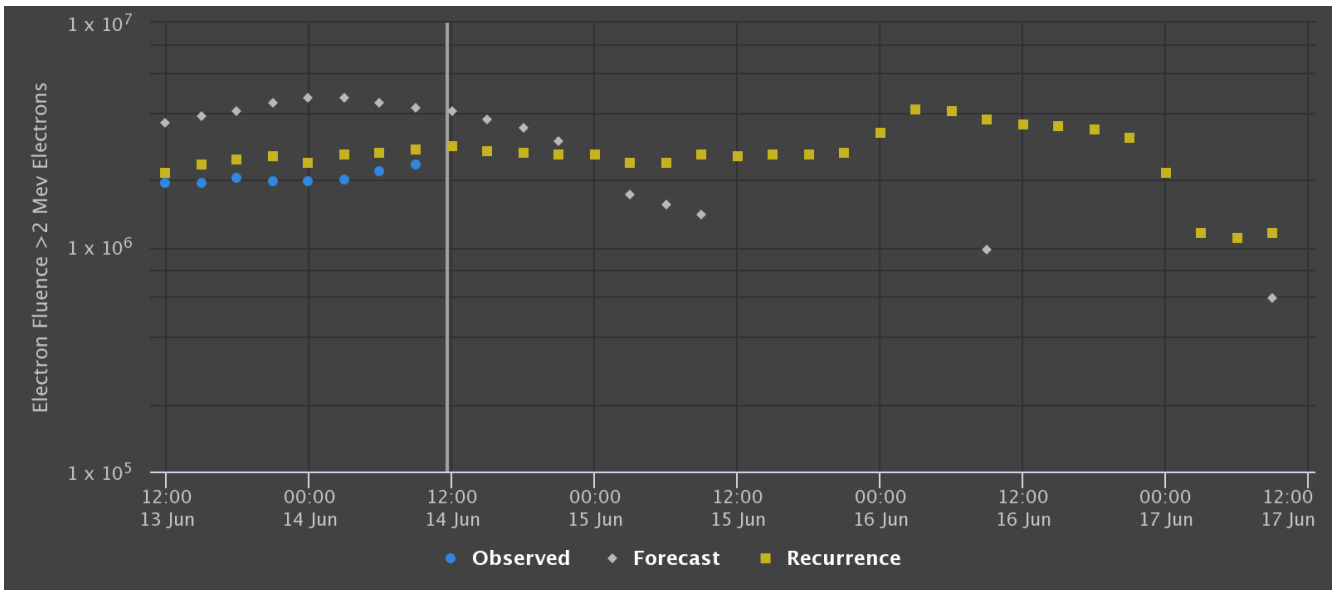
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is expected to be at Background, until at least later on day 3 (16 Jun). A fast wind enhancement, currently forecast to occur late day 2 (15 Jun), may connect sufficiently to increase electron counts through the Van Allen Belts. This may then result in Moderate flux at GEO from day 3 (16 Jun), perhaps briefly High at diurnal max.

The associated 24 hr electron fluence is expected to remain steady and below the Active (1e8 integrated pfu) threshold days 1-3 (14-16 Jun), with the REFM model currently providing generally good guidance for this period. An increasing trend is then expected later day 3 and through day 4 (16 and 17 Jun), but remaining below the Active threshold.

GEO Electron Environment	Level ($cm^{-2}\ sr^{-1}\ day^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 6: REFM election fluence – observations and forecast.



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